Review

Rapid Shallow Breathing Index Measurement, Modifications, and Predictive Performance for Ventilator Weaning in Adult ICU Patients: A Scoping Review

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ABSTRACT

Background: The Rapid Shallow Breathing Index (RSBI) is widely used to assess readiness for ventilator weaning in mechanically ventilated patients. However, variations in measurement methods, cut-off values, modifications, and predictive performance have resulted in heterogeneous evidence. This scoping review aimed to map the available evidence on RSBI measurement methods, modifications, and predictive performance for ventilator weaning outcomes in adult ICU patients.

Methods: This scoping review followed the Arksey and O'Malley framework and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines. The Population–Concept–Context (PCC) framework guided the research question. Literature searches were conducted in PubMed, ScienceDirect, ProQuest, SAGE Journals, and EBSCOhost for English-language primary studies published between 2015 and 2026. Data were extracted using a structured charting process and analyzed through thematic synthesis.

Results: Of the 461 identified records, 18 primary studies met the inclusion criteria. Four main themes were identified: conventional RSBI performance, variability in measurement methods and cut-off values, serial RSBI monitoring during spontaneous breathing trials, and diaphragm ultrasound-based RSBI modifications. Conventional RSBI showed variable predictive performance across studies because of differences in patient characteristics, ventilator settings, SBT protocols, measurement techniques, and outcome definitions.

Conclusion: RSBI remains a simple and non-invasive bedside parameter for ventilator weaning assessment; however, conventional RSBI should not be used as a stand-alone predictor. Its interpretation should be integrated with comprehensive clinical assessment and patient characteristics. Future multicenter studies are needed to standardize RSBI measurement protocols and validate diaphragm ultrasound-based RSBI modifications across diverse ICU populations.

Keywords: Rapid Shallow Breathing Index; Ventilator Weaning; Extubation; Mechanical Ventilation; Critical Care; Intensive Care Units.

Implications for Practice:

- RSBI can be used as a rapid, non-invasive bedside parameter during spontaneous breathing trials (SBT) to support ventilator weaning decisions and to early identify the risk of extubation failure. In low- and middle-income countries (LMICs), RSBI is particularly practical because it can be applied with basic monitoring equipment and adapted to local resource constraints.
- ICU nurses play a key role in monitoring respiratory parameters, detecting SBT intolerance, documenting RSBI trends, and collaborating within multidisciplinary teams. RSBI implementation should be supported by structured training and context-appropriate protocols to ensure consistent and sustainable use, including in LMIC settings.
- Healthcare institutions should update ventilator weaning protocols by integrating RSBI with other clinical assessments, including diaphragm ultrasonography where available, to improve the accuracy of weaning decisions and reduce complications such as reintubation.

Introduction

Mechanical ventilation (MV) is an essential life-support therapy in the management of critically ill patients in the Intensive Care Unit (ICU), particularly in patients with acute respiratory failure and severe respiratory disorders (Arriagada et al., 2025). The use of mechanical ventilation aims to maintain adequate oxygenation and ventilation while reducing the patient's work of breathing during the critical phase of illness (Mi et al., 2026). Mechanical ventilation is a major component of intensive care management, with approximately 39–72% of ICU patients requiring invasive mechanical ventilation, depending on patient characteristics, disease severity, and ICU setting (Q. Wang et al., 2023). Nevertheless, prolonged use of mechanical ventilation may lead to various complications, including ventilator-associated pneumonia (VAP), respiratory muscle weakness, diaphragmatic dysfunction, prolonged ICU length of stay, and increased patient morbidity and mortality (Meléndez-oliva et al., 2026).

The liberation process from mechanical ventilation remains a major clinical challenge in ICU practice. Approximately one in four mechanically ventilated patients may experience prolonged weaning or death despite undergoing spontaneous breathing trials (SBT), indicating the complexity of achieving successful ventilator discontinuation (Sterr et al., 2024). Furthermore, extubation failure and reintubation remain important clinical concerns after planned extubation, with approximately 10–20% of extubated patients requiring reintubation, and the rate increasing to 20–30% among high-risk populations (Q. Wang et al., 2023). These outcomes highlight the importance of accurate assessment tools to identify patients who are ready for ventilator liberation and those at risk of weaning or extubation failure. One of the most important stages in the management of patients receiving mechanical ventilation is the ventilator weaning process (Karthika et al., 2016). Ventilator weaning is the gradual discontinuation of mechanical ventilatory support until the patient can maintain spontaneous ventilation independently. The success of the weaning process significantly influences patient outcomes, as premature discontinuation of ventilatory support may lead to respiratory failure and reintubation. In contrast, delayed discontinuation may increase the risk of complications such as pneumonia, diaphragmatic atrophy, delirium, venous thromboembolism, and prolonged ICU stay (Vahedian-azimi & Gohari-moghadam, 2022). The ventilator weaning process has been reported to account for more than 50% of the total duration of mechanical ventilation use in ICU patients, making it one of the most critical phases in mechanical ventilation management (Y. Wang et al., 2025).

The burden of mechanical ventilation and weaning failure is particularly relevant in low- and middle-income countries (LMICs), including developing countries in the ASEAN region. Compared with high-income countries, ICU practices in LMICs may differ due to variations in ICU capacity, availability of advanced respiratory monitoring technologies, respiratory therapy services, staffing resources, and standardized ventilator weaning protocols (Turhan et al., 2024). These differences may influence clinical decision-making and the implementation of evidence-based ventilator liberation strategies. Therefore, simple, accessible, and reliable bedside assessment tools remain essential to support safe ventilator weaning practices, particularly in resource-limited healthcare settings (Sterr et al., 2024).

The success of ventilator weaning is influenced by various physiological factors, including pulmonary function, respiratory muscle strength, diaphragmatic function, hemodynamic status, level of consciousness, and the patient's ability to maintain spontaneous ventilation (Garcia-Blanco & Lehker, 2019). From a physiological perspective, successful weaning depends on the balance between respiratory muscle capacity and respiratory workload. Increased respiratory demand, reduced tidal volume generation, and impaired diaphragmatic performance may result in rapid shallow breathing patterns and contribute to weaning failure. Therefore, various predictive parameters have been developed to assist clinicians in determining patient readiness for spontaneous breathing trials (SBT) and extubation (Yamanoglu, 2022).

Commonly used parameters include tidal volume (VT), minute ventilation, maximal inspiratory pressure (MIP), and the Rapid Shallow Breathing Index (Song et al., 2022). Rapid Shallow Breathing Index (RSBI) is one of the most widely used predictive parameters for weaning in clinical practice (Vahedian-azimi & Gohari-moghadam, 2022). RSBI is calculated based on the ratio between respiratory rate (RR) and the patient's spontaneous tidal volume (f/VT). This index was first introduced by Yang and Tobin in 1991 as a simple method for predicting ventilator liberation success. An RSBI value of <105 breaths/min/L has classically been associated with successful weaning, whereas a value of >105 breaths/min/L has been associated with a higher risk of weaning failure (Menguy et al., 2023). The widespread use of RSBI is supported by its ease of measurement, non-invasive nature, and practical bedside application (Song et al., 2022).

Conceptually, RSBI reflects the interaction between respiratory rate, tidal volume, respiratory muscle workload, and ventilatory efficiency (Garcia-blanco & Lehker, 2019). However, extubation success cannot be determined solely by RSBI values, as it also requires adequate diaphragmatic function, airway protection, cardiovascular stability, neurological status, and the ability to sustain spontaneous breathing. Therefore, RSBI should be interpreted as part of a multidimensional assessment approach rather than as a single predictor of extubation outcomes (Y. Wang et al., 2025).

Although RSBI has been widely used in clinical practice, its predictive ability for successful ventilator weaning remains inconsistent across studies (Yamanoglu, 2022). Several studies have reported that RSBI has good sensitivity in predicting successful weaning and extubation. However, other studies have shown that using RSBI as a single parameter does not always accurately predict extubation success across ICU patient populations (Menguy et al., 2023). In addition, RSBI measurements may be influenced by several factors, including ventilator mode, the use of pressure support ventilation (PSV), continuous positive airway pressure

(CPAP), sedation level, patient position, anxiety, and characteristics of specific patient populations, including patients with chronic obstructive pulmonary disease (COPD), neurological patients, and cardiac surgery patients (Song et al., 2022).

Recent research has demonstrated modifications and advancements to RSBI that improve the predictive ability of ventilator weaning outcomes (Mowafy & Abdelgalel, 2019). One emerging modification is the diaphragmatic rapid shallow breathing index (D-RSBI), which combines respiratory rate with diaphragmatic displacement measured using diaphragmatic ultrasonography (Mowafy & Abdelgalel, 2019). This approach integrates respiratory pattern assessment with diaphragm performance evaluation, providing additional information regarding respiratory muscle capacity during weaning. D-RSBI has been reported to demonstrate better diagnostic accuracy than conventional RSBI in predicting successful ventilator weaning (Song et al., 2022). Furthermore, serial RSBI measurements and monitoring RSBI changes during spontaneous breathing trials (SBT) have demonstrated better predictive performance than single measurements, supporting more accurate extubation decision-making (Shamil et al., 2022).

Not only in invasive mechanical ventilation, but also in patients undergoing noninvasive ventilation (NIV), the application of RSBI has expanded. A study by Acar and Yamanoglu reported that an RSBI value of >105 breaths/min/L was associated with increased intubation requirements and mortality among patients with acute respiratory failure receiving NIV in the emergency department. These findings suggest that RSBI has broader potential applications in critical care practice (Menguy et al., 2023).

Although research on RSBI continues to develop, the available scientific evidence remains heterogeneous across study design, patient population, measurement methods, cut-off values, clinical applications, and ventilator weaning outcomes (Karthika et al., 2023). Previous systematic reviews have mainly focused on diagnostic accuracy; however, limited attention has been given to comprehensively mapping the evolution of RSBI measurement methods, index modifications, and clinical applications across different ICU settings. Therefore, a knowledge gap remains regarding how RSBI should be optimally applied to support ventilator weaning decisions in diverse clinical contexts (Chung et al., 2024). The main research gaps identified include the lack of standardized RSBI measurement protocols, variations in RSBI cut-off values across different ICU populations, limited evidence from multicenter studies, absence of consensus regarding the optimal interval for serial RSBI assessment, and limited external validation of diaphragmatic rapid shallow breathing index (D-RSBI) and other diaphragm ultrasound-based indices. These limitations contribute to uncertainty regarding the optimal application of RSBI in predicting ventilator weaning and extubation outcomes across diverse clinical settings (Jia & Wang, 2024).

A scoping review is an appropriate methodological approach for broadly mapping scientific evidence, identifying research characteristics, evaluating key concepts, and identifying research gaps related to the use of RSBI in ventilator weaning outcomes (Arksey et al., 2005). This approach enables researchers to explore various types of scientific evidence and provide a comprehensive overview of RSBI development among mechanically ventilated patients in the ICU (Simpson & Pap, 2023). Therefore, this scoping review was conducted to map and synthesize scientific evidence on the role of the Rapid Shallow Breathing Index (RSBI) in ventilator weaning outcomes among patients receiving mechanical ventilation, including research characteristics, measurement methods, index modifications, clinical applications, and findings related to successful and unsuccessful ventilator weaning.

Methods

Design

This study employed a scoping review methodology to map and synthesize scientific evidence regarding the role of the Rapid Shallow Breathing Index (RSBI) in predicting ventilator weaning outcomes among patients receiving mechanical ventilation. A scoping review design was selected instead of a systematic review because the aim of this study was not to estimate the effectiveness, diagnostic accuracy, or pooled impact of RSBI, but rather to map the breadth, characteristics, measurement approaches, clinical applications, and development of available evidence. Given the heterogeneity of RSBI measurement methods, cut-off values, ventilator weaning protocols, patient characteristics, and clinical settings, a scoping review was deemed appropriate to identify patterns of evidence, clarify existing concepts, and explore knowledge gaps for future research. Using the Population–Concept–Context (PCC) framework, this scoping review followed the methodological framework proposed by Arksey and O'Malley, further refined by Levac et al.. It was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR). A comprehensive literature search was conducted in PubMed, ScienceDirect, ProQuest, SAGE Journals, and EBSCOhost to identify English-language studies published between 2015 and 2026. The research question was developed using the PCC framework. The Population included adult patients receiving mechanical ventilation in the Intensive Care Unit (ICU). The Concept was the application of RSBI, including conventional measurement methods, cut-off values, modified indices, and clinical applications in ventilator weaning. The Context was critical care practice related to ventilator weaning outcomes. The research question was: "How does the Rapid Shallow Breathing Index (RSBI), including its measurement methods, cut-off values, modified indices, and clinical applications, predict ventilator weaning outcomes in adult patients receiving mechanical ventilation in the ICU?"

Eligibility Criteria

Studies included in this scoping review addressed the application of the Rapid Shallow Breathing Index (RSBI) in ventilator weaning among adult patients receiving mechanical ventilation in Intensive Care Unit (ICU) settings. The inclusion criteria were: (1) adult patients aged ≥18 years receiving invasive or non-invasive mechanical ventilation; (2) studies evaluating RSBI as a predictor of ventilator weaning success, weaning failure, or extubation outcomes; (3) studies reporting RSBI measurement methods, cut-off values, modified indices, or clinical applications; (4) primary research studies, including observational studies, prospective and retrospective cohort studies, case-control studies, cross-sectional studies, diagnostic accuracy studies, and randomized controlled trials; and (5) full-text articles published in peer-reviewed journals. Only primary studies were included in the final synthesis to avoid duplication of evidence and ensure that the review was based on original research findings. Studies published between 2015 and 2026 were included because this period reflects contemporary developments in ventilator weaning assessment, including advances in RSBI measurement techniques, serial RSBI monitoring approaches, and modifications to RSBI based on diaphragm ultrasound. This timeframe was selected to capture current clinical applications and methodological developments while maintaining relevance to modern ICU practice. Only studies published in English were included because English is the predominant language of international biomedical publications and provides access to the majority of high-quality critical care research indexed in major electronic databases. This language restriction was applied to ensure consistency in study interpretation and accurate synthesis of the available evidence. The exclusion criteria were: (1) studies involving pediatric or neonatal populations; (2) editorials, letters to the editor, commentaries, conference abstracts, protocols, and expert opinions; (3) review articles, including systematic reviews, meta-analyses, and narrative reviews; (4) studies not specifically addressing RSBI in ventilator weaning; (5) articles without full-text availability; and (6) duplicate publications identified during the screening process.

Information Sources

A systematic literature search was conducted using several electronic databases, including PubMed, ScienceDirect, ProQuest, SAGE Journals, and EBSCOhost. These databases were selected to obtain comprehensive scientific evidence on RSBI use during ventilator weaning in adult patients receiving mechanical ventilation in the ICU. The search included articles published between 2015 and 2026 and written in English. In addition to database searching, manual screening of reference lists (hand searching) was performed to identify additional studies not captured by the primary search strategy. No direct contact with study authors was conducted to obtain additional data.

Search Strategy

The search strategy was developed using the PCC framework to ensure a comprehensive and reproducible identification of relevant evidence. A preliminary pilot search was conducted in PubMed to identify relevant keywords, Medical Subject Headings (MeSH) terms, and additional concepts related to the Rapid Shallow Breathing Index (RSBI), ventilator weaning, and mechanical ventilation. The research team reviewed the pilot search results to refine and optimize the search terms before conducting the final search. The final search strategy combined controlled vocabulary terms, free-text keywords, and Boolean operators (AND/OR), and was applied across five electronic databases: PubMed, ScienceDirect, ProQuest, SAGE Journals, and EBSCOhost. The search strategy was adapted according to the syntax requirements of each database while maintaining consistency in the core concepts. The main search terms included (“Rapid Shallow Breathing Index” OR “RSBI” OR “rapid shallow breathing”) AND (“ventilator weaning” OR “weaning outcome” OR “weaning success” OR “weaning failure” OR “extubation” OR “spontaneous breathing trial”) AND (“mechanical ventilation” OR “mechanically ventilated patients” OR “critical care” OR “intensive care unit” OR “ICU”). Additional terms were incorporated to identify studies involving RSBI modifications, including (“diaphragmatic rapid shallow breathing index” OR “D-RSBI” OR “modified RSBI” OR “diaphragm ultrasound” OR “diaphragm thickening fraction” OR “DTF” OR “integrative weaning index”). Search limits included English-language, full-text, peer-reviewed articles published between 2015 and 2026. The complete database-specific search strategies are provided in Supplementary Table X to enhance transparency and reproducibility. The research team reviewed the final search strategy to ensure alignment with the PCC framework and the objectives of this scoping review.

Selection Process

Study selection followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines. All retrieved records were exported into a reference management software to identify and remove duplicates. Two reviewers independently screened titles and abstracts according to predefined inclusion and exclusion criteria. Potentially relevant studies were then assessed in full text to determine eligibility. During the eligibility stage, full-text articles were independently evaluated by both reviewers based on Population, Concept, and Context alignment, as well as relevance to RSBI use in ventilator weaning. Studies that did not meet inclusion criteria or that met exclusion criteria were removed, with reasons documented. Disagreements between reviewers were resolved through discussion to reach consensus. If consensus could not be reached, a third reviewer was consulted for the final decision. The entire selection process was presented in a PRISMA-ScR flow diagram.

Data Collection Process

Data extraction was conducted on all studies meeting the inclusion criteria. A structured data extraction form was developed based on the study objectives and the PCC framework. The first reviewer performed data extraction using the standardized form. To enhance the accuracy and consistency of the extracted information, the extracted data were subsequently reviewed by the second and third reviewers. Any discrepancies or uncertainties identified during the review process were discussed among the reviewers until consensus was reached. Extracted data included study characteristics, RSBI measurement methods, cut-off values, RSBI modifications, and ventilator weaning outcomes. No author contact or automated tools were used for additional data collection.

Data Charting Process

Data charting was performed using a structured extraction form developed by the researchers based on the research objectives and research question. Before full data charting, the research team reviewed the extraction form and charting categories to ensure clarity, relevance, and consistency with the PCC framework. This preliminary review helped align the reviewers' understanding of the charting variables and procedures. One reviewer conducted systematic full-text data charting using the standardized form. The second and third reviewers subsequently reviewed the charted data for accuracy, completeness, and consistency. Any discrepancies or uncertainties identified during the charting process were discussed among the reviewers until consensus was achieved. Extracted information included study characteristics, sample characteristics, RSBI measurement methods, cut-off values, RSBI modifications, clinical applications, and ventilator weaning outcomes. No contact was made with the original study investigators, as all required data were available in the published full-text articles.

Data Items

Extracted data included: (1) study characteristics (author, publication year, country, and study design); (2) population characteristics (sample size and patient population); (3) RSBI-related variables (measurement method, timing of assessment, cut-off values, and RSBI modifications); and (4) ventilator weaning outcomes (weaning success or failure, extubation success or failure, reintubation, sensitivity, specificity, and area under the curve [AUC]). Study design was defined as the methodological approach used in each study. Patient population referred to the clinical characteristics of mechanically ventilated adult ICU patients. RSBI measurement method referred to the technique used to obtain RSBI values, whereas RSBI modifications included diaphragm ultrasound-based indices and other derived parameters. Weaning outcomes were defined according to the criteria reported in each included study. During synthesis, similar outcomes were grouped into unified categories to facilitate comparison across studies.

Synthesis of Results

Extracted data were analyzed and summarized using a descriptive synthesis approach to map the evidence regarding the role of RSBI in ventilator weaning outcomes in adult ICU patients. Due to heterogeneity in study designs, populations, RSBI measurement methods, cut-off values, modifications, and reported outcomes, no quantitative synthesis or meta-analysis was performed. Data were organized into summary tables to facilitate comparison across studies. Findings were then thematically grouped, including conventional RSBI use, modified RSBI, serial RSBI measurements, diaphragm ultrasound-based approaches, and predictive performance of RSBI for weaning and extubation outcomes. Results were presented in narrative and tabular formats to describe study characteristics, evidence development, patterns, and remaining research gaps.

Results

Selection of Sources of Evidence

The literature search identified 461 records from five electronic databases, including ProQuest (n = 146), PubMed (n = 118), SAGE Journals (n = 61), EBSCOhost (n = 52), and ScienceDirect (n = 84). After removing 86 duplicate records, 375 articles remained for title and abstract screening. During this stage, 271 articles were excluded because they were not relevant to the review objective, leaving 104 articles for full-text assessment. Following the full-text review, 87 articles were excluded for the following reasons: insufficient methodological description (n = 48), not specifically related to the use of the Rapid Shallow Breathing Index (RSBI) in ventilator weaning outcomes (n = 17), failure to report weaning or extubation outcomes (n = 8), unavailable full-text articles (n = 5), pediatric or neonatal populations (n = 4), conference abstracts, editorials, or commentary articles (n = 2), and review articles, including systematic reviews, meta-analyses, and narrative reviews (n = 2). Consequently, 18 primary studies met the eligibility criteria and were included in this scoping review. The study selection process is presented in Figure 1 according to the PRISMA-ScR framework.

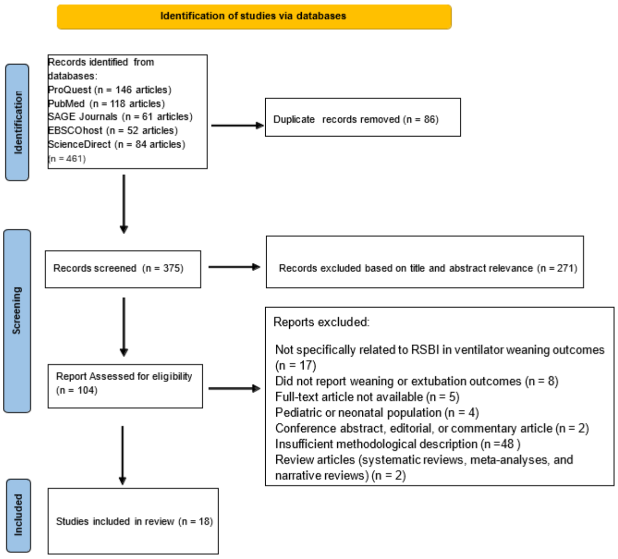

Figure 1. PRISMA-ScR Flow Diagram

Characteristics of Sources of Evidence

A total of 18 primary studies published between 2015 and 2026 were included in this scoping review. The studies originated from various countries, including India, China, South Korea, Brazil, Egypt, Turkey, Thailand, Germany, Indonesia, Saudi Arabia, and several multinational studies. Most studies employed prospective observational designs, while other study designs included prospective and retrospective cohort studies, cross-sectional studies, randomized controlled trials, and diagnostic accuracy studies. The majority of the included studies involved adult patients receiving invasive mechanical ventilation in Intensive Care Units (ICUs), including patients with acute respiratory failure, acute exacerbation of chronic obstructive pulmonary disease (AECOPD), prolonged mechanical ventilation, tracheostomy, postoperative conditions, and neurological disorders. The primary objective of the included studies was to evaluate the predictive performance of the Rapid Shallow Breathing Index (RSBI) for successful ventilator weaning and extubation. Several studies also investigated modified RSBI parameters based on diaphragm ultrasonography and serial RSBI measurements during spontaneous breathing trials (SBTs) to improve prediction accuracy. Table 1 summarizes the characteristics of the included studies, including study design, sample size, RSBI assessment approach, study objectives, and the main findings related to ventilator weaning and extubation outcomes.

Table 1. Summary of the Characteristics of Included Studies

Author (Year)	Country	Study Design	Sample	RSBI Theme	Study Focus	Main Findings
(Shamil et al., 2022)	India	Prospective observational study	50 ICU patients receiving mechanical ventilation for≥48 hours	Ultrasound-Based RSBI	Compared the accuracy of the Diaphragmatic Rapid Shallow Breathing Index (D-RSBI) with conventional RSBI in predicting weaning success	D-RSBI demonstrated higher diagnostic accuracy than conventional RSBI in predicting successful ventilator weaning.
(Chung et al., 2024)	South Korea	Prospective observational study	35 ICU patients undergoing spontaneous breathing trial	Ultrasound-Based RSBI	Evaluated modified diaphragm ultrasound-based RSBI (DTi-RSBI) for predicting weaning success	DTi-RSBI showed better predictive performance for weaning success compared with several sonographic indices and conventional RSBI.
(Song et al., 2022)	China	Prospective observational study	110 ICU patients receiving mechanical ventilation for>48 hours	Ultrasound-Based RSBI	Evaluated the accuracy of diaphragm ultrasound-based weaning indices (Diaphragmatic Excursion RSBI (DE-RSBI) and Diaphragm Thickening Fraction	Diaphragm Thickening Fraction RSBI (DTF-RSBI) (AUC 0.859) and Diaphragmatic Excursion RSBI (DE-RSBI) (AUC 0.813) were more accurate than RSBI (AUC 0.639) in

Author (Year)	Country	Study Design	Sample	RSBI Theme	Study Focus	Main Findings
					RSBI (DTF-RSBI), compared with traditional RSBI	predicting weaning failure.
(Turhan et al., 2024)	Turkey	Prospective observational study	86 ICU patients	Serial/Rate-of-Change RSBI	Assessed the predictive value of serial RSBI measurements for extubation success	Serial RSBI significantly predicted extubation success; the combination of RSBI-2a ≤72 and ΔRSBI ≤−3 increased the probability of success by 28.48-fold.
(Huo et al., 2020)	China	Prospective clinical study	50 patients receiving mechanical ventilation for>72 hours	Integrative/Combined RSBI	Evaluated the ability of the Integrative Weaning Index (IWI) to predict weaning success	IWI demonstrated high accuracy (AUC up to 0.91) with sensitivity of 0.91 and specificity of 0.83, outperforming traditional indices.
(Bellan et al., 2025)	India	Prospective cohort study	50 adult patients receiving mechanical ventilation >24 hours	Ultrasound-Based RSBI	Compared the accuracy of lung and diaphragm ultrasound with RSBI in predicting weaning success	Diaphragm ultrasound parameters, particularly DTI (AUC 0.948), were superior; combining DTI with RSBI improved accuracy to 94%.
(Tunggal et al., 2026)	Indonesia	Prospective diagnostic accuracy study	56 ICU patients receiving mechanical ventilation (>24 hours)	Ultrasound-Based RSBI	Compared the diagnostic accuracy of Diaphragm Thickening Fraction (DTF) and RSBI in predicting weaning success	RSBI demonstrated better diagnostic performance (AUC 0.88 vs 0.79) with high sensitivity. DTF remained useful as an additional parameter for assessing diaphragmatic function.
(Mowafy & Abdelgalel, 2019)	Egypt	Prospective randomized clinical trial	106 mechanically ventilated patients (>48 hours)	Ultrasound-Based RSBI	Compared Diaphragmatic RSBI (D-RSBI) with conventional RSBI in predicting weaning success.	DRSBI, particularly at the 30th minute of SBT, showed the best diagnostic accuracy (cut-off <1.6), outperforming traditional RSBI.
(Duarte et al., 2023)	Brasil	Randomized crossover trial	33 intubated patients receiving mechanical ventilation	Conventional RSBI (Measurement Method)	Compared different RSBI measurement methods (ventilometer vs ventilator parameters: PSV and CPAP)	RSBI values in CPAP mode were equivalent to ventilometer measurements, whereas PSV values were lower. Ventilometer measurement remained recommended for borderline values.
(Ghiani et al., 2024)	Jerman	Prospective observational cohort study	140 tracheostomized patients with prolonged weaning	Integrative/Combined RSBI	Compared the mechanical power density with respiratory indices (RSBI, VT/PBW, IWI) in predicting long-term weaning failure	Mechanical power density demonstrated the highest accuracy (Area Under the Receiver Operating Characteristic Curve (AUROC) 0.91), outperforming RSBI (0.62) in predicting weaning failure.
(Chao Xie, Wang & Chen, 2026)	China	Prospective study	136 patients with cervical spinal cord injury	Ultrasound-Based RSBI	Evaluated diaphragm ultrasound parameters (DE, DTF, DCV (Diaphragmatic Contraction Velocity), D-RSBI) in predicting weaning success	The combination of parameters (DE, DTF, DCV (Diaphragmatic Contraction Velocity), D-RSBI) provided the best predictive value (AUC >0.70), outperforming single parameters.
(Rittayamai et al., 2021)	Thailand	Prospective cohort study	47 mechanically ventilated patients ready for weaning	Serial/Rate-of-Change RSBI	Validated ventilator-displayed RSBI (RSBIvent) compared with the standard Wright spirometer method (RSBI standard)	RSBIvent significantly overestimated values compared with the standard method. The mean RSBI from five time points (0–60 seconds)

Author (Year)	Country	Study Design	Sample	RSBI Theme	Study Focus	Main Findings
						showed the best correlation (r=0.76; ICC=0.79). Serial measurements improved accuracy compared with a single measurement.
(Karthika et al., 2023)	Uni Emirat Arab, India	Prospective observational study	160 ICU patients	Serial/Rate-of-Change RSBI	Evaluated whether RSBI changes between minutes 5 and 120 (RSBI 5–120) were more accurate than a single RSBI value at minute 120 in predicting extubation outcomes.	Changes in RSBI between minutes 5 and 120 during spontaneous breathing trials were more accurate than a single RSBI measurement at minute 120 in predicting extubation failure.
(Souza et al., 2015)	Brasil	Prospective observational study	109 adult ICU patients receiving mechanical ventilation (>24 hours) and considered candidates for weaning	Conventional RSBI (Measurement Method)	Compared the performance of traditionally calculated RSBI (spirometer) and ventilator-based RSBI in predicting weaning success	Ventilator-based RSBI demonstrated equivalent accuracy to spirometer-based measurements in predicting weaning success, with high reliability and lower cut-off values.
(Shaykhah M Albashir, 2025)	Arab Saudi / USA	Retrospective cohort study	1,313 ICU patients	Conventional RSBI (Cut-off Evaluation)	Evaluated updated RSBI cut-off values	The classic cut-off (<105) may be less optimal in modern clinical practice and may require adjustment based on newer evidence.
(Abbas et al., 2018)	Mesir	Prospective observational study	50 AECOPD patients receiving mechanical ventilation (>48 hours) and ready for SBT	Ultrasound-Based RSBI	Compared the Diaphragmatic Rapid Shallow Breathing Index (D-RSBI) with traditional RSBI in predicting weaning outcomes	D-RSBI demonstrated higher diagnostic accuracy than RSBI (AUC 0.97 vs 0.67). A D-RSBI cut-off >1.9 provided sensitivity of 84.6% and specificity of 100%.
(Bien et al., 2015)	Brasil	Prospective cross-sectional study	195 ICU patients (medical and surgical patients aged ≥15 years receiving mechanical ventilation)	Integrative/Combined RSBI	Analyzed the predictive ability of Maximum Inspiratory Pressure (MIP) and RSBI in determining successful ventilator weaning	MIP demonstrated higher accuracy, sensitivity, and specificity than RSBI (AUC 0.95 vs 0.89). However, both MIP and RSBI were significant predictors of successful ventilator weaning.
(Varón-vega et al., 2024)	Multinational (COBRE-US trial)	Prospective multicenter observational study (secondary analysis)	367 ICU patients receiving mechanical ventilation	Conventional RSBI (Prediction of SBT and Extubation)	Evaluated the predictive ability of RSBI for SBT and extubation success	RSBI was not significantly associated with SBT or extubation success (AUC 0.48–0.53). Correlations with ventilation duration and ventilator-free days were very weak.

RSBI Measurement Methods

The mapping results demonstrated variations in RSBI measurement methods across studies. Most studies used conventional spirometer- or ventilometer-based methods, whereas several studies used ventilator-based RSBI obtained directly from ventilator parameters. Studies by (Souza et al., 2015; Duarte et al., 2023) showed that ventilator-based RSBI had relatively comparable diagnostic performance to the spirometer method under certain ventilation conditions. However, Duarte et al. (2023) reported that RSBI values measured during Continuous Positive Airway Pressure (CPAP) mode produced results similar to those obtained using a ventilometer, whereas measurements performed during Pressure Support Ventilation (PSV) mode resulted in lower RSBI values compared with the standard method. In patients with borderline values, ventilometer-based measurements remained recommended because they provided better sensitivity in detecting the risk of weaning failure. In addition, Rittayamai et al. (2021) reported that ventilator-displayed RSBI tended to overestimate results compared with the standard spirometer method. Nevertheless, serial measurements at multiple time points demonstrated better reliability and correlation than single measurements.

Factors Influencing Variability in RSBI Cut-off Values

The variability in RSBI cut-off values observed across the included studies is likely attributable to differences in patient characteristics, ventilator settings, timing of RSBI measurement, and study objectives (Duarte et al., 2023; Rittayamai et al., 2021; Turhan et al., 2024). Studies involving patients with acute exacerbation of chronic obstructive pulmonary disease (AECOPD) or prolonged mechanical ventilation generally reported higher optimal cut-off values than studies involving heterogeneous ICU populations because of differences in respiratory mechanics, respiratory muscle workload, and diaphragmatic function.(Varón-vega et al., 2024;Shamil et al., 2022; Shaykhah M Albashir, 2025). These findings suggest that a single universal RSBI threshold may not be appropriate for all critically ill patients, and interpretation should be individualized according to the clinical context.

RSBI Modifications and Diaphragm Ultrasound-Based Indices

Several studies reported the use of diaphragm ultrasound-based RSBI modifications, including the Diaphragmatic Rapid Shallow Breathing Index (D-RSBI), Diaphragm Thickening Fraction RSBI (DTF-RSBI), Diaphragm Inspiratory Time RSBI (DTi-RSBI), and Diaphragmatic Excursion RSBI (DE-RSBI). (Abbas et al., 2018) reported that D-RSBI demonstrated superior predictive performance, with an AUC of 0.97 compared with 0.67 for conventional RSBI. (Song et al., 2022)) reported AUC values of 0.859 for DTF-RSBI and 0.813 for DE-RSBI, whereas conventional RSBI demonstrated an AUC value of 0.639. (Chung et al., 2024) Evaluated the use of DTi-RSBI in predicting successful ventilator weaning. D-RSBI demonstrated a sensitivity of 0.88, specificity of 0.82, and AUC of 0.93 (Turhan et al., 2024).

Serial RSBI Measurements

Several studies evaluated the use of serial RSBI measurements during spontaneous breathing trials (SBT). (Turhan et al., 2024) reported an association between the combination of serial RSBI measurements and changes in RSBI values (ΔRSBI) and extubation success. (Karthika et al., 2023) evaluated changes in RSBI values between the 5th and 120th minutes during SBT in predicting extubation outcomes. (Rittayamai et al., 2021) reported that the average RSBI measurements obtained from multiple time points demonstrated better reliability and correlation compared with single measurements.

Reported Weaning Outcomes

The primary outcomes reported across studies included successful ventilator weaning, successful extubation, weaning failure, reintubation, prolonged mechanical ventilation, and ventilator-free days (Turhan et al., 2024). In addition to conventional RSBI, several studies also evaluated combinations of RSBI with other physiological parameters or integrative indices, such as the Integrative Weaning Index (IWI) and mechanical power density, in predicting ventilator weaning and extubation outcomes (Huo et al., 2020; Ghiani et al., 2024).

Discussion

Heterogeneity of RSBI Measurements

The findings of this scoping review indicate that studies investigating the Rapid Shallow Breathing Index (RSBI) in predicting successful ventilator weaning remain heterogeneous across studies. This variation is likely influenced by differences in patient populations, ICU settings, ventilator modes, timing of measurements, and RSBI measurement methods used. Variations in patient characteristics, such as pulmonary disease, neurological disorders, postoperative conditions, and prolonged mechanical ventilation, may affect respiratory patterns and patient tolerance during spontaneous breathing trials (SBT), thereby influencing the obtained RSBI values (Turhan et al., 2024; Zhang et al., 2024). In addition to population characteristics, RSBI measurement methods also contribute to variations in clinical interpretation. The use of ventilator-based RSBI has been reported to produce different values compared with measurements obtained using standard spirometers or ventilometers. These differences may be influenced by ventilator circuit resistance, endotracheal tube compensation, and ventilator mode during measurement (Rittayamai et al., 2021; Duarte et al., 2023). Variations were also observed in the RSBI cut-off values used. The classic threshold of ≤105 breaths/min/L remains widely used; however, several studies suggest that this value may not be optimal in modern mechanical ventilation practice (Karthika et al., 2023; Shaykhah M Albashir, 2025). These findings indicate that there is still no consistent standardization of RSBI measurements across studies and clinical practice. This condition represents one of the major contributors to variations in the predictive accuracy of ventilator weaning and extubation outcomes. Therefore, the development of more standardized RSBI measurement protocols is needed, including standardization of measurement timing, ventilator mode, and cut-off values appropriate for modern ICU patient characteristics (Menguy et al., 2023; Turhan et al., 2024). A remaining research gap is the limited number of multicenter studies and randomized controlled trials evaluating the standardization of RSBI measurement methods in heterogeneous ICU populations.

Predictive Ability of Conventional RSBI

The Rapid Shallow Breathing Index (RSBI) remains one of the most widely used bedside parameters for assessing readiness for ventilator weaning because it is simple, non-invasive, inexpensive, and easy to apply in ICU settings. Physiologically, an increased RSBI reflects a rapid and shallow breathing pattern associated with increased respiratory muscle workload, reduced alveolar ventilation, and a higher risk of diaphragmatic fatigue (Chung et al., 2024). Nevertheless, the findings of this scoping review demonstrate considerable inconsistency in the predictive performance of conventional RSBI across studies. While several studies reported acceptable diagnostic accuracy, others found that RSBI alone had limited ability to predict successful extubation or spontaneous breathing trial (SBT) outcomes. The conflicting findings are likely explained by substantial clinical and methodological heterogeneity among the included studies. First, differences in patient populations significantly influenced RSBI performance. Studies involving patients with acute exacerbation of chronic obstructive pulmonary disease (AECOPD) generally reported higher diagnostic accuracy because respiratory mechanics and diaphragmatic workload are the primary determinants of weaning success. In contrast, studies involving heterogeneous ICU populations, neurological disorders, prolonged mechanical ventilation, or tracheostomized patients frequently demonstrated lower predictive performance because extubation failure in these populations is often related to impaired airway protection, neurological dysfunction, excessive airway secretions, or ventilator-induced diaphragm dysfunction rather than respiratory mechanics alone (Varón-vega et al., 2024; Mowafy & Abdelgalel, 2019; Turhan et al., 2024; Mowafy & Abdelgalel, 2019).

Second, variations in ventilator modes used during RSBI assessment contributed to differences in reported diagnostic performance. Duarte et al. (2023) demonstrated that RSBI values obtained during Continuous Positive Airway Pressure (CPAP) were comparable to those measured using a standard ventilometer, whereas measurements performed during Pressure Support Ventilation (PSV) tended to produce lower RSBI values because inspiratory assistance reduced patient respiratory effort. Consequently, RSBI measured during PSV may overestimate a patient's readiness for extubation, particularly in patients with borderline respiratory reserve.

Third, differences in spontaneous breathing trial (SBT) protocols further contributed to inconsistent findings. Some studies evaluated RSBI at a single time point, whereas others assessed serial RSBI measurements throughout the SBT. Serial monitoring appears to better reflect progressive respiratory muscle fatigue and patient tolerance to spontaneous breathing, thereby providing superior predictive performance compared with a single measurement. This finding was consistently demonstrated by Karthika et al. (2023), Turhan et al. (2024), and Rittayamai et al. (2021), suggesting that dynamic changes in RSBI may provide greater clinical value than isolated measurements.

Finally, variability in outcome definitions also affected the reported predictive performance of RSBI. Although all studies evaluated ventilator weaning, the primary outcomes differed considerably, including successful spontaneous breathing trials, successful extubation, reintubation, prolonged weaning, ventilator-free days, and long-term weaning outcomes. Because these outcomes represent different stages of the weaning process and are influenced by different physiological mechanisms, variation in diagnostic accuracy across studies is expected. Therefore, the conflicting evidence observed in this review should be interpreted in the context of differences in study populations, ventilator settings, SBT protocols, RSBI measurement techniques, and outcome definitions rather than being interpreted as evidence that conventional RSBI lacks clinical utility (Shaykhah M Albashir, 2025; Turhan et al., 2024)

Overall, these findings indicate that conventional RSBI should not be used as a stand-alone predictor of ventilator weaning success. Instead, RSBI should be interpreted together with comprehensive clinical assessment, patient-specific characteristics, respiratory mechanics, diaphragmatic function, and serial physiological monitoring to support more accurate and individualized weaning decisions in adult ICU patients (Shamil et al., 2022; Varón-vega et al., 2024; Tunggal et al., 2026).

Added Value of Diaphragm Ultrasonography and RSBI Modifications

Recent research developments indicate a shift in the assessment approach for ventilator weaning readiness from the use of a single RSBI parameter toward a multidimensional approach integrating respiratory and diaphragmatic function. The integration of RSBI with diaphragm ultrasonography parameters, such as diaphragmatic excursion (DE), diaphragm thickening fraction (DTF), and Diaphragmatic Rapid Shallow Breathing Index (D-RSBI), offers the potential to improve the predictive accuracy of extubation success because these parameters directly assess diaphragmatic mechanical function (Abbas et al., 2018; Zhang et al., 2024).

Clinically, the use of diaphragm ultrasound-based parameters may facilitate early identification of diaphragmatic weakness, which is often undetected using conventional RSBI alone. This approach is particularly important in patients receiving prolonged mechanical ventilation or patients with neuromuscular disorders who are at high risk for extubation failure. In addition, combining RSBI with other physiological parameters, such as the Integrative Weaning Index (IWI) and mechanical power density, demonstrates that extubation readiness assessment is evolving toward a more comprehensive and multidimensional approach (Huo et al., 2020; Song et al., 2022. However, the implementation of diaphragm ultrasonography in ICU practice still has several limitations, including the need for operator training, variability in examination techniques, limited equipment availability, and the lack of standardized cut-off values. Moreover, most available studies still use observational designs with relatively small sample sizes (Ghiani et al., 2024). Therefore, future studies should evaluate the validity and reliability of diaphragm ultrasound-based RSBI modification parameters through multicenter studies and randomized controlled trials to support the development of evidence-based ventilator weaning protocols.

Implications for Low- and Middle-Income Countries and ASEAN Settings

The findings of this review are particularly relevant for low- and middle-income countries (LMICs), including many countries in the ASEAN region, where ICU resources, staffing levels, and access to advanced respiratory monitoring technologies may be limited (Bartlett et al., 2023). In these settings, conventional RSBI remains attractive because it is inexpensive, non-invasive, and can be performed using routinely available ventilator parameters. However, variability in ventilator equipment, ICU protocols, and workforce capacity may contribute to inconsistent RSBI measurement and interpretation. Consequently, the development of standardized and context-appropriate RSBI protocols may help improve ventilator weaning practices in resource-constrained settings (Menguy et al., 2023; Spencer et al., 2023).

Resource Constraints and Workforce Considerations

The implementation of advanced weaning assessment tools, such as diaphragm ultrasonography, may be challenging in resource-limited ICUs due to equipment availability, financial constraints, and the need for specialized training. Furthermore, variations in professional roles, workforce composition, and clinical competencies across healthcare systems may influence the feasibility of integrating ultrasound-based assessments into routine practice. Therefore, future implementation strategies should consider local resource availability, workforce development, and training requirements to ensure equitable adoption across diverse healthcare settings (Ginsburg et al., 2023; Huo et al., 2020; Bartlett et al., 2023).

Mechanistic Perspective of Diaphragm Dysfunction

The superior performance of diaphragm ultrasound-based RSBI modifications may be explained by the pathophysiology of ventilator-induced diaphragm dysfunction (VIDD). Prolonged mechanical ventilation can lead to diaphragmatic muscle atrophy, reduced contractility, and impaired neuromuscular function. Conventional RSBI primarily reflects breathing frequency and tidal volume and may not adequately capture diaphragmatic mechanical performance. In contrast, diaphragm ultrasound parameters directly assess diaphragmatic excursion and thickening during respiration, providing additional physiological information that may improve the prediction of weaning and extubation outcomes (Wu & Chasteen, 2024; Song et al., 2022; Itagaki et al., 2024).

Theoretical Contribution

From a theoretical perspective, the findings support a shift from a single-parameter respiratory assessment model toward a multidimensional framework for ventilator weaning assessment. The inconsistent predictive performance of conventional RSBI across the included studies suggests that ventilator weaning readiness is influenced by multiple interacting physiological and clinical factors rather than respiratory frequency and tidal volume alone. Variations in patient characteristics, ventilator settings, spontaneous breathing trial protocols, RSBI measurement techniques, and outcome definitions further reinforce the need for an integrated assessment approach. Consequently, this review advances the conceptual understanding that RSBI should be interpreted as one component of a comprehensive weaning assessment, integrated with diaphragmatic function, respiratory mechanics, neuromuscular capacity, and overall clinical evaluation to improve decision-making during ventilator weaning (Ghiani et al., 2024; Jia & Wang, 2024; Poddighe et al., 2024).

Implications and limitations

This scoping review contributes to theoretical and scientific development in ventilator weaning by reinforcing RSBI as a practical, non-invasive bedside tool in spontaneous breathing trial (SBT) assessment. The findings support a shift from single-parameter evaluation toward a multidimensional approach that integrates respiratory mechanics, diaphragmatic function, neuromuscular capacity, and patient tolerance. The addition of diaphragm ultrasound-based RSBI modifications further enhances weaning assessment by enabling direct evaluation of diaphragmatic performance. Overall, these findings support the development of more comprehensive, multidisciplinary, and evidence-based weaning strategies to improve clinical decision-making and patient outcomes in ICU settings.

This scoping review has several limitations. First, only English-language publications were included, which may have introduced language bias and resulted in the exclusion of potentially relevant studies published in other languages. Second, although multiple major electronic databases were searched, some relevant studies indexed in other databases or unpublished grey literature may not have been identified. Third, only primary studies published between 2015 and 2026 were included to minimize overlapping evidence; therefore, relevant evidence published outside this timeframe was not considered. Finally, substantial heterogeneity was observed across the included studies with respect to patient populations, ventilator settings, RSBI measurement techniques, spontaneous breathing trial (SBT) protocols, cut-off values, and outcome definitions. This heterogeneity precluded direct comparison of findings across studies and should be considered when interpreting the reported variability in the predictive performance of conventional RSBI.

Relevance to Practice

The findings of this scoping review can be directly applied in critical care nursing practice by integrating the Rapid Shallow Breathing Index (RSBI) into routine assessment during spontaneous breathing trials (SBT) to support timely and evidence-based ventilator weaning decisions. ICU nurses may use RSBI alongside clinical parameters such as respiratory rate, tidal volume, oxygenation status, and SBT tolerance to identify patients at risk of extubation failure and support nurse-led weaning protocols. In multidisciplinary ICU practice, RSBI should be embedded within structured clinical decision-making pathways involving nurses, physicians, and respiratory therapists, with serial measurements and trend monitoring to improve consistency in decision-making. In resource-limited settings, RSBI remains a feasible, low-cost bedside tool, while advanced modalities such as diaphragm ultrasonography may be integrated where available to enhance assessment accuracy.

Conclusion

This scoping review demonstrates that conventional RSBI remains a practical and non-invasive bedside tool for ventilator weaning assessment; however, its predictive performance varies across clinical settings and should not be interpreted as a stand-alone predictor of weaning success. Differences in patient characteristics, ventilator settings, spontaneous breathing trial protocols, RSBI measurement techniques, and outcome definitions contribute substantially to this variability. Integrating RSBI with diaphragmatic function assessment and serial physiological monitoring may improve the accuracy of weaning decisions. Future multicenter studies should establish standardized RSBI measurement protocols and validate integrated weaning models across diverse ICU populations.

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CrediT Authorship Contributions Statement

Tatang Sopyan: Conceptualization, Methodology, Literature Search, Data Curation, Formal Analysis, Investigation, Visualization, Writing – Original Draft.

Ayu Prawesti Priambodo: Methodology, Validation, Supervision, Writing – Review & Editing.

Aan Nuraeni: Validation, Supervision, Writing – Review & Editing, Project Administration

Conflicts of Interest

There is no conflict of interest.

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